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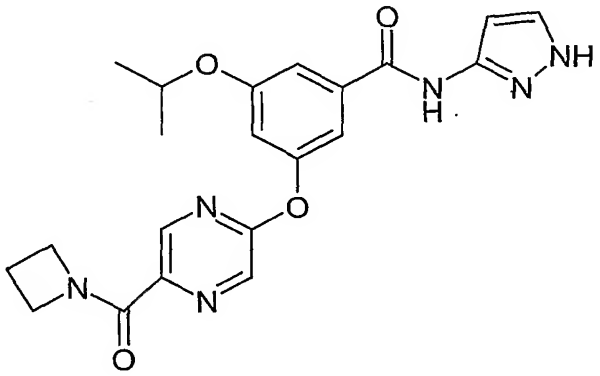
(54) Title: NOVEL CRYSTALLINE COMPOUND USEFUL AS GLK ACTIVATOR

(57) Abstract: A novel crystalline form of 3-{[5-(azetidin-1-ylcarbonyl)pyrazin-2-yl]oxy}-5-[(1-methylethyl)oxy]-N-1H-pyrazol-3-ylbenzamide is described in the specification. This compound is a glucokinase (GLK or GK) activator and useful as a pharmaceutical agent in the treatment or prevention of a disease or medical condition mediated through GLK, leading to a decreased glucose threshold for insulin secretion. Processes for the manufacture of the crystalline form, pharmaceutical compositions comprising the crystalline form and the use of the crystalline form in medical treatment are also described.

NOVEL CRYSTALLINE COMPOUND USEFUL AS GLK ACTIVATOR

The present invention relates to a novel crystalline chemical compound and more particularly to a novel crystalline form of 3-{[5-(azetidin-1-ylcarbonyl)pyrazin-2-yl]oxy}-5-[(1-methylethyl)oxy]-N-1H-pyrazol-3-ylbenzamide, hereinafter referred to as "the Agent", and illustrated in Formula (I) hereinafter, which compound is a glucokinase (GLK or GK) activator and useful as a pharmaceutical agent in the treatment or prevention of a disease or medical condition mediated through GLK, leading to a decreased glucose threshold for insulin secretion. The invention also relates to processes for the manufacture of the crystalline form, pharmaceutical compositions comprising the crystalline form and the use of the crystalline form in medical treatment.



(I)

International patent application PCT/GB2006/002471 (WO2007/007041) discloses the Agent in 2 different crystalline forms (Example 39k). One was crystallised from acetonitrile and had a melting point (melting onset) 108.5 °C. This form will hereinafter be referred to as Form A. The other crystalline from described on page 176 of WO2007/007041 had a melting point (melting onset) of 113.8°C. This form will hereinafter be referred to as Form A'. The preparation of Form A is also described in the Example hereinafter. Form A and Form A' convert to the amorphous form in aqueous media. The amorphous form has a different solubility profile to the Form A. Stable crystalline forms that do not convert to other forms with different solubilities in aqueous media are preferred for pharmaceutical formulations.

We have now surprisingly and unexpectedly discovered a second crystalline form of the Agent that is significantly more stable than Form A and Form A' and does not

significantly convert to other forms in aqueous media. This form of the Agent will hereinafter be referred to as Form B.

Form B is characterised in providing at least one of the following 2-theta (2θ) values measured using CuKa radiation: 24.6° and 18.0°.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 24.6°.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with at least one specific peak at about 2-theta = 18.0°.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with at least two specific peaks at about 2-theta = 24.6° and 18.0°.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with at least three specific peaks at about 2-theta = 24.6°, 18.0° and 25.6 °.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with at least four specific peaks at about 2-theta = 24.6°, 18.0°, 25.6 ° and 23.8 °.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with at least five specific peaks at about 2-theta = 24.6°, 18.0°, 25.6 °, 23.8 ° and 11.5 °.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with at least six specific peaks at about 2-theta = 24.6°, 18.0°, 25.6 °, 23.8 °, 11.5 ° and 9.1 °.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with specific peaks at about 2-theta = 24.6 °, 18.0 °, 25.6°, 23.8 °, 11.5 °, 9.1°, 22.9 °, 15.9 °, 14.9° and 22.0°.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern substantially the same as the X-ray powder diffraction pattern shown in Figure A.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 24.6° plus or minus 0.5° 2-theta.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 18.0° plus or minus 0.5° 2-theta.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with at least two specific peaks at 2-theta = 24.6° and 18.0° wherein said values may be plus or minus 0.5° 2-theta.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with specific peaks at 2-theta = 24.6 °, 18.0 °, 25.6°, 23.8 °, 11.5 °, 9.1°, 22.9 °, 15.9 °, 14.9° and 22.0° wherein said values may be plus or minus 0.5° 2-theta.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 24.6°.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with at least one specific peak at 2-theta = 18.0°.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with at least two specific peaks at 2-theta = 24.6° and 18.0°.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern with specific peaks at 2-theta = 24.6 °, 18.0 °, 25.6°, 23.8 °, 11.5 °, 9.1°, 22.9 °, 15.9 °, 14.9 ° and 22.0 °.

According to the present invention there is provided a crystalline form of the Agent, which has an X-ray powder diffraction pattern substantially as shown in Figure A.

Form B is characterised in providing an X-ray powder diffraction pattern, substantially as shown in Figure A. The ten most prominent peaks are shown in Table A

Table A

Ten most Prominent X-Ray Powder Diffraction peaks for Form B

Angle 2-Theta (2θ)	Intensity %	Relative Intensity
24.573	100	vs
18.011	74.5	vs
25.577	61.4	vs
23.753	57.5	vs
11.510	43.1	vs
9.107	38.9	vs
22.885	35.7	vs
15.947	34.7	vs
14.872	33.4	vs
21.968	33.4	vs

vs = very strong

Differential Scanning Calorimetry (DSC) analysis shows Form B is a high melting solid with an onset of melting at 136.8° C and a peak at 142.5° C (Figure B).

When it is stated that the present invention relates to a crystalline form of the Agent in Form B, the degree of crystallinity is conveniently greater than about 60%. More conveniently, it is greater than about 80%. Particularly, it is greater than about 90%. More particularly, it is greater than about 95%. Most particularly, the degree of crystallinity is greater than about 98%.

Form B (IPA Form) provides X-ray powder diffraction patterns substantially the same as the X-ray powder diffraction patterns shown in Figure A and has substantially the ten most prominent peaks (angle 2-theta values) shown in Table A. It will be understood that the 2-theta values of the X-ray powder diffraction pattern may vary slightly from one machine to another or from one sample to another, and so the values quoted are not to be construed as absolute.

It is known that an X-ray powder diffraction pattern may be obtained which has one or more measurement errors depending on measurement conditions (such as equipment or machine used). In particular, it is generally known that intensities in an X-ray powder diffraction pattern may fluctuate depending on measurement conditions. Therefore it should be understood that Form B (IPA Form) of the present invention is not limited to the crystals

that provide X-ray powder diffraction patterns identical to the X-ray powder diffraction pattern shown in Figure A, and any crystals providing X-ray powder diffraction patterns substantially the same as those shown in Figure A fall within the scope of the present invention. A person skilled in the art of X-ray powder diffraction is able to judge the substantial identity of X-ray powder diffraction patterns.

Persons skilled in the art of X-ray powder diffraction will realise that the relative intensity of peaks can be affected by, for example, grains above 30 microns in size and non-unitary aspect ratios, which may affect analysis of samples. The skilled person will also realise that the position of reflections can be affected by the precise height at which the sample sits in the diffractometer and the zero calibration of the diffractometer. The surface planarity of the sample may also have a small effect. Hence the diffraction pattern data presented are not to be taken as absolute values. (Jenkins, R & Snyder, R.L. 'Introduction to X-Ray Powder Diffractometry' John Wiley & Sons 1996; Bunn, C.W. (1948), Chemical Crystallography, Clarendon Press, London; Klug, H. P. & Alexander, L. E. (1974), X-Ray Diffraction Procedures).

Generally, a measurement error of a diffraction angle in an X-ray powder diffractogram is about 5% or less, in particular plus or minus 0.5° 2-theta, and such degree of a measurement error should be taken into account when considering the X-ray powder diffraction pattern in Figure A and when reading Table A. Furthermore, it should be understood that intensities might fluctuate depending on experimental conditions and sample preparation (preferred orientation).

As mentioned hereinabove, Form B is a more stable form of the compound of the Formula (I) than Form A. Competitive slurries of Form A and Form B in a range of solvents show that Form B is the most stable form. Form B also has a much higher melting endotherm.

Form B may be obtained by slurrying form A in isopropanol (propan-2-ol).

Therefore in a further aspect of the present invention is provided a process for the manufacture of Form B of a compound of formula (I), which comprises forming crystals from a saturated solution of compound of formula (I) in isopropanol.

Saturation of the solution with the Agent means addition of, for example the amorphous form to the sodium salt solution until the solution is saturated with respect to the

amorphous form. Further amorphous form is added to maintain the saturation once crystallisation of Form B has started.

The process of the invention is conveniently carried out between 15 and 45°C, more conveniently at ambient temperature.

Form B may also be formed by seeding an isopropanol solution or slurry of Form A of the Agent, or by prolonged stirring of a suspension of the amorphous form.

The utility of the compound of the invention may be demonstrated by standard tests and clinical studies, including those described in International patent application publication number WO03/015774, which is hereby incorporated by reference.

A further feature of the invention is a pharmaceutical composition comprising Form B of the Agent, together with a pharmaceutically-acceptable diluent or carrier.

According to another aspect of the invention there is provided the use of a Form B of the Agent for use as a medicament.

According to another aspect of the invention there is provided Form B of the Agent for use as a medicament for treatment of a disease mediated through GLK, in particular type 2 diabetes.

Further according to the invention there is provided the use Form B of the Agent in the preparation of a medicament for treatment of a disease mediated through GLK, in particular type 2 diabetes.

The compound is suitably formulated as a pharmaceutical composition for use in this way.

According to another aspect of the present invention there is provided a method of treating GLK mediated diseases, especially diabetes, by administering an effective amount of Form B of the Agent to a mammal in need of such treatment.

Specific diseases which may be treated by a compound or composition of the invention include: blood glucose lowering in Type 2 Diabetes Mellitus without a serious risk of hypoglycaemia (and potential to treat type 1), dyslipidemia, obesity, insulin resistance, metabolic syndrome X, impaired glucose tolerance.

The GLK/GLKRP system can be described as a potential "Diabesity" target (of benefit in both Diabetes and Obesity). Thus, according to another aspect of the invention there is provided the use of a Form B of the Agent, in the preparation of a medicament for use in the combined treatment or prevention, particularly treatment of diabetes and obesity.

According to another aspect of the invention there is provided the use of Form B of the Agent in the preparation of a medicament for use in the treatment or prevention, particularly treatment of obesity.

According to another aspect of the invention there is provided Form B of the Agent for use as a medicament for treatment or prevention, particularly treatment of obesity.

According to a further aspect of the invention there is provided a method for the combined treatment of obesity and diabetes by administering an effective amount of Form B of the Agent, to a mammal in need of such treatment.

According to a further aspect of the invention there is provided a method for the treatment of obesity by administering an effective amount of Form B of the Agent to a mammal in need of such treatment.

The compositions of the invention may be in a form suitable for oral use (for example as tablets, lozenges, hard or soft capsules, aqueous or oily suspensions, emulsions, dispersible powders or granules, syrups or elixirs), for topical use (for example as creams, ointments, gels, or aqueous or oily solutions or suspensions), for administration by inhalation (for example as a finely divided powder or a liquid aerosol), for administration by insufflation (for example as a finely divided powder) or for parenteral administration (for example as a sterile aqueous or oily solution for intravenous, subcutaneous, intramuscular or intramuscular dosing or as a suppository for rectal dosing). Dosage forms suitable for oral use are preferred.

The compositions of the invention may be obtained by conventional procedures using conventional pharmaceutical excipients, well known in the art. Thus, compositions intended for oral use may contain, for example, one or more colouring, sweetening, flavouring and/or preservative agents.

Suitable pharmaceutically acceptable excipients for a tablet formulation include, for example, inert diluents such as lactose, sodium carbonate, calcium phosphate or calcium carbonate, granulating and disintegrating agents such as corn starch or algenic acid; binding agents such as starch; lubricating agents such as magnesium stearate, stearic acid or talc; preservative agents such as ethyl or propyl p-hydroxybenzoate, and anti-oxidants, such as ascorbic acid. Tablet formulations may be uncoated or coated either to modify their disintegration and the subsequent absorption of the active ingredient within the gastrointestinal tract, or to improve their stability and/or appearance, in either case, using conventional coating agents and procedures well known in the art.

Compositions for oral use may be in the form of hard gelatin capsules in which the active ingredient is mixed with an inert solid diluent, for example, calcium carbonate, calcium phosphate or kaolin, or as soft gelatin capsules in which the active ingredient is mixed with water or an oil such as peanut oil, liquid paraffin, or olive oil.

Aqueous suspensions generally contain the active ingredient in finely powdered form together with one or more suspending agents, such as sodium carboxymethylcellulose, methylcellulose, hydroxypropylmethylcellulose, sodium alginate, polyvinyl-pyrrolidone, gum tragacanth and gum acacia; dispersing or wetting agents such as lecithin or condensation products of an alkylene oxide with fatty acids (for example polyoxethylene stearate), or condensation products of ethylene oxide with long chain aliphatic alcohols, for example heptadecaethyleneoxycetanol, or condensation products of ethylene oxide with partial esters derived from fatty acids and a hexitol such as polyoxyethylene sorbitol monooleate, or condensation products of ethylene oxide with long chain aliphatic alcohols, for example heptadecaethyleneoxycetanol, or condensation products of ethylene oxide with partial esters derived from fatty acids and a hexitol such as polyoxyethylene sorbitol monooleate, or condensation products of ethylene oxide with partial esters derived from fatty acids and hexitol anhydrides, for example polyethylene sorbitan monooleate. The aqueous suspensions may also contain one or more preservatives (such as ethyl or propyl p-hydroxybenzoate, anti-oxidants (such as ascorbic acid), colouring agents, flavouring agents, and/or sweetening agents (such as sucrose, saccharine or aspartame).

Oily suspensions may be formulated by suspending the active ingredient in a vegetable oil (such as arachis oil, olive oil, sesame oil or coconut oil) or in a mineral oil (such as liquid paraffin). The oily suspensions may also contain a thickening agent such as beeswax, hard paraffin or cetyl alcohol. Sweetening agents such as those set out above, and flavouring agents may be added to provide a palatable oral preparation. These compositions may be preserved by the addition of an anti-oxidant such as ascorbic acid.

Dispersible powders and granules suitable for preparation of an aqueous suspension by the addition of water generally contain the active ingredient together with a dispersing or wetting agent, suspending agent and one or more preservatives. Suitable dispersing or wetting agents and suspending agents are exemplified by those already mentioned above. Additional excipients such as sweetening, flavouring and colouring agents, may also be present.

The pharmaceutical compositions of the invention may also be in the form of oil-in-water emulsions. The oily phase may be a vegetable oil, such as olive oil or arachis oil, or a mineral oil, such as for example liquid paraffin or a mixture of any of these. Suitable emulsifying agents may be, for example, naturally-occurring gums such as gum acacia or gum tragacanth, naturally-occurring phosphatides such as soya bean, lecithin, an esters or partial esters derived from fatty acids and hexitol anhydrides (for example sorbitan monooleate) and condensation products of the said partial esters with ethylene oxide such as polyoxyethylene sorbitan monooleate. The emulsions may also contain sweetening, flavouring and preservative agents.

Syrups and elixirs may be formulated with sweetening agents such as glycerol, propylene glycol, sorbitol, aspartame or sucrose, and may also contain a demulcent, preservative, flavouring and/or colouring agent.

The pharmaceutical compositions may also be in the form of a sterile injectable aqueous or oily suspension, which may be formulated according to known procedures using one or more of the appropriate dispersing or wetting agents and suspending agents, which have been mentioned above. A sterile injectable preparation may also be a sterile injectable solution or suspension in a non-toxic parenterally-acceptable diluent or solvent, for example a solution in 1,3-butanediol.

Compositions for administration by inhalation may be in the form of a conventional pressurised aerosol arranged to dispense the active ingredient either as an aerosol containing finely divided solid or liquid droplets. Conventional aerosol propellants such as volatile fluorinated hydrocarbons or hydrocarbons may be used and the aerosol device is conveniently arranged to dispense a metered quantity of active ingredient.

For further information on formulation the reader is referred to Chapter 25.2 in Volume 5 of Comprehensive Medicinal Chemistry (Corwin Hansch; Chairman of Editorial Board), Pergamon Press 1990.

The amount of active ingredient that is combined with one or more excipients to produce a single dosage form will necessarily vary depending upon the host treated and the particular route of administration. For example, a formulation intended for oral administration to humans will generally contain, for example, from 0.5 mg to 2 g of active agent compounded with an appropriate and convenient amount of excipients which may vary from about 5 to about 98 percent by weight of the total composition. Dosage unit forms will

generally contain about 1 mg to about 500 mg of an active ingredient. For further information on Routes of Administration and Dosage Regimes the reader is referred to Chapter 25.3 in Volume 5 of Comprehensive Medicinal Chemistry (Corwin Hansch; Chairman of Editorial Board), Pergamon Press 1990.

The size of the dose for therapeutic or prophylactic purposes of a compound will naturally vary according to the nature and severity of the conditions, the age and sex of the animal or patient and the route of administration, according to well known principles of medicine.

In using a compound of the Form B for therapeutic or prophylactic purposes it will generally be administered so that a daily dose in the range, for example, 0.5 mg to 75 mg per kg body weight is received, given if required in divided doses. In general lower doses will be administered when a parenteral route is employed. Thus, for example, for intravenous administration, a dose in the range, for example, 0.5 mg to 30 mg per kg body weight will generally be used. Similarly, for administration by inhalation, a dose in the range, for example, 0.5 mg to 25 mg per kg body weight will be used. Oral administration is however preferred.

In the following non-limiting Examples, unless otherwise stated:

(i) evaporations were carried out by rotary evaporation in *vacuo* and work-up procedures were carried out after removal of residual solids such as drying agents by filtration;

(ii) operations were carried out at room temperature, that is in the range 18-25°C and under an atmosphere of an inert gas such as argon or nitrogen;

(iii) yields are given for illustration only and are not necessarily the maximum attainable;

(iv) the structures of the end-products of the Formula (I) were confirmed by nuclear (generally proton) magnetic resonance (NMR) with a field strength (for proton) of 300MHz (generally using a Varian Gemini 2000) or 400 MHz (generally using a Bruker Avance DPX400), unless otherwise stated, and mass spectral techniques; proton magnetic resonance chemical shift values were measured on the delta scale and peak multiplicities are shown as follows: s, singlet; d, doublet; t, triplet; m, multiplet; br, broad; q, quartet, quin, quintet;

(v) Purification by chromatography generally refers to flash column chromatography, on silica unless otherwise stated. Column chromatography was generally carried out using

prepacked silica cartridges (from 4g up to 400g) such as Redisep™ (available, for example, from Presearch Ltd, Hitchin, Herts, UK) or Biotage (Biotage UK Ltd, Hertford, Herts, UK), eluted using a pump and fraction collector system. Purification by Solid Phase Extraction (SPE) methods generally refers to the use of chromatography cartridges packed with SPE materials such as ISOLUTE® SCX-2 columns (available, for example, From International Sorbent Technology Ltd, Dryffryn Business Park, Hengoed, Mid Glamorgan, UK);

(iv) Melting points were generally carried out by Differential Scanning Calorimetry (DSC). It will be understood that the onset and/or peak temperature values of the DSC may vary slightly from one machine to another, one method to another or from one sample to another, and so the values quoted are not to be construed as absolute. It will be appreciated that some samples may be solvates and that this may also affect melting points.

Abbreviations

DCM	dichloromethane
DSC	differential scanning calorimetry
XRPD	X-ray powder diffraction

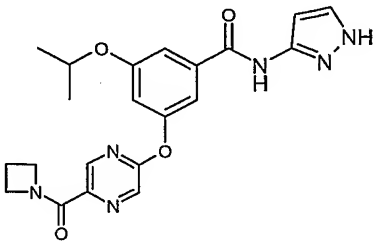
Example 1

Preparation of 3-{[5-(azetidin-1-ylcarbonyl)pyrazin-2-yl]oxy}-5-[(1-methylethyl)oxy]-N-1H-pyrazol-3-ylbenzamide – Form B

The X-ray powder diffraction spectra for Form A showed the material to be crystalline. This material had a melting point of 108.5°C (onset). In order to produce the second crystalline form, Form B, 200mg of material was placed in a vial with a magnetic flea, and 2ml of isopropanol (IPA) added. The vial was then sealed tightly with a cap. The slurry was then left to stir on a magnetic plate at ambient temperature (25°C). After 3 days, the sample was removed from the plate, the cap taken off and the slurry left to dry under ambient conditions before it was analysed by XRPD and DSC. This form (Form B) was determined to be crystalline by XRPD and seen to be different to Form A. This material (Form B) had a melting point of 136.8°C (onset).

Form A may be prepared as described in PCT/GB2006/002471 (WO2007/007041) or as follows:

3-{[5-(Azetidin-1-ylcarbonyl)pyrazin-2-yl]oxy}-5-[(1-methylethyl)oxy]-N-1H-pyrazol-3-ylbenzamide – Form A



tert-Butyl 3-[(3-hydroxy-5-propan-2-yloxy-benzoyl)amino]pyrazole-1-carboxylate (56.3 g) was dissolved in acetonitrile (500 ml) and charged to a 3L fixed vessel. Potassium carbonate (325 mesh, 64.5g) was added, followed by azetidin-1-yl-(5-chloropyrazin-2-yl)methanone (33.5 g) with an acetonitrile charge wash (100 ml). The mixture was stirred rapidly and warmed to 60°C under nitrogen. Extra acetonitrile (250 ml) was added and the mixture stirred at 60°C for 20 hours.

After cooling to room temperature the potassium carbonate was filtered off and the filtrate was concentrated under vacuum to remove the acetonitrile. The residual solution was poured into water (1500 ml) with stirring and the precipitated solid was filtered off. The solid was dissolved in dichloromethane (560 ml), washed with 1:1 brine/saturated sodium hydrogen carbonate (2 × 500 ml) and dried ($MgSO_4$). Trifluoroacetic acid (100 ml) was added and the solution was stirred at room temperature for 20 hours. The solvent was removed under vacuum and azeotroped with toluene. The residue was dissolved in ethyl acetate (500 ml) and washed with saturated sodium hydrogen carbonate (2 x 500 ml), brine (500 ml) dried ($MgSO_4$) and concentrated to leave a waxy solid (64 g). This was triturated with ethyl acetate (200 ml) at 45°C for 2 hr. The solid was filtered off, washed with ethyl acetate and dried in a vacuum oven at 40°C overnight to leave a solid (52 g). The crude solid was purified by flash chromatography on silica, eluting with methanol containing 2% ammonia in dichloromethane (0.5 to 6.5%) to afford the title compound (48.4 g).

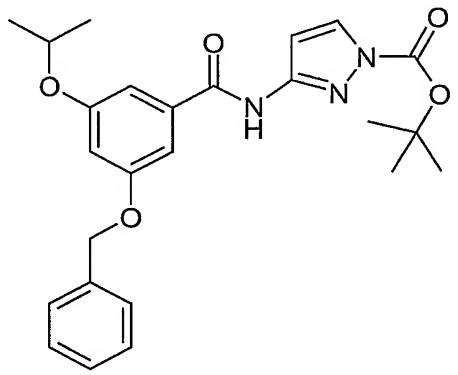
The solid was dissolved in refluxing ethyl acetate (900 ml). Small amount of undissolved extraneous material remained. The solution was filtered whilst hot and cooled to 60°C, isohexane (250 ml) was added dropwise (at the end of the addition cloudiness remained). The slurry was cooled to 20°C over approx 1 hour and then stirred at room temp

for 20 hours. The slurry was filtered and washed with isohexane (2 × 200 ml). The solid was dried in a vacuum oven at 60°C for 24 hours afford the title compound as form A (33.1 g). ^{1}H NMR δ (400 MHz, $CDCl_3$) 1.36 (6H, d), 2.34 - 2.42 (2H, m), 4.25 (2H, t), 4.55 - 4.61 (1H, m), 4.68 (2H, t), 6.83 (1H, d), 7.25 (1H, t), 7.33 - 7.34 (1H, m), 7.39 (1H, d), 8.37 (1H, d), 8.80 (1H, d), 10.42 (1H, s).

Form B may also be prepared in a similar way using form A' instead of form A.

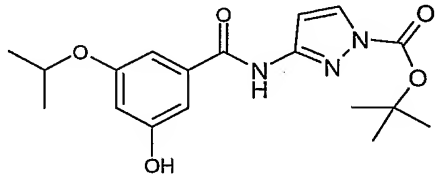
The starting materials were prepared as follows:

tert-Butyl 3-[(3-phenylmethoxy-5-propan-2-yloxy-benzoyl)amino]pyrazole-1-carboxylate



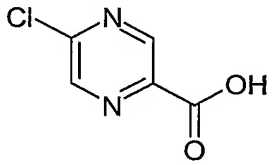
A solution of oxalyl chloride (76 ml) in dichloromethane (125 ml) was added dropwise to a slurry of 3-phenylmethoxy-5-propan-2-yloxy-benzoic acid (CAS no. 852520-53-7) (50 g) and dimethylformamide (1 ml) in dichloromethane (300 ml). The resulting solution was stirred at room temperature for 2 hours. The solvent was removed under vacuum and azeotroped with toluene (200 ml). The residue was dissolved in dry pyridine (100 ml). The mixture was added slowly to a mixture of tert-butyl 3-aminopyrazole-1-carboxylate (CAS no. 863504-84-1) (38.4 g) in dry pyridine (325 ml) under nitrogen over 5 minutes. The mixture was stirred at room temperature for 1 hour and solvent was removed under vacuum and azeotroped with toluene. The residue was partitioned between dichloromethane (500 ml) and water (500 ml) and the organic layer was washed with saturated sodium hydrogen carbonate (500 ml) and brine (500 ml) and dried ($MgSO_4$) and concentrated under vacuum, azeotroped twice with toluene to leave a residue which was purified by flash chromatography, eluting with 25-50% ethyl acetate in isohexane (25 to 50%) to afford the title compound (76.4 g).

tert-Butyl 3-[(3-hydroxy-5-propan-2-yloxy-benzoyl)amino]pyrazole-1-carboxylate



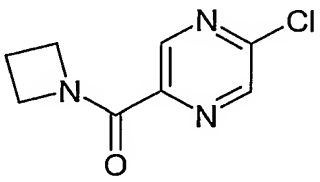
To a solution of tert-butyl 3-[(3-phenylmethoxy-5-propan-2-yloxy-benzoyl)amino]pyrazole-1-carboxylate (76.4 g) in methanol (764 ml) was added 10% palladium on carbon (7.6 g) and the resulting mixture was stirred under an atmosphere of hydrogen at a pressure of 5 bar for 20 hours. The catalyst was removed by filtration through Celite. The filtrate was concentrated under vacuum to leave a solid (66 g). This was purified by flash chromatography on silica, eluting with ethyl acetate in isohexane (10 to 70%) to give the title compound (56.4 g).

5-Chloropyrazine-2-carboxylic acid



Methyl 5-chloropyrazine-2-carboxylate (CAS no. 33332-25-1)(345.1 g) was dissolved in DMF (1.73 l). Lithium chloride (423.9 g) was added and the mixture heated to 140°C over one hour. The mixture was evaporated, and the residue dissolved in water (3.4 l) by continued stirring. The solution was acidified by addition of 2N HCl (900 ml) and extracted into ethyl acetate (5 × 1.73 l). The combined organic extracts were washed with water (2 × 900 ml), brine (900 ml), dried ($MgSO_4$), and evaporated to give the title compound (298.1 g). ^1H NMR δ (400.132 MHz, DMSO) 8.92 (d, 1H), 9.02 (d, 1H), 13.87 (s, 1H).

Azetidin-1-yl-(5-chloropyrazin-2-yl)methanone



5-Chloropyrazine-2-carboxylic acid (277.4 g) was added to a solution of oxalyl chloride (186.5 ml) in dichloromethane (3.1 l) and the resulting mixture was stirred for 3 hours. The residue was dissolved in DCM (6.2 l), filtered and added to a solution of azetidine hydrochloride (CAS no. 36520-39-5) (180 g) and triethylamine (560 ml) in DCM (3.1 l). The mixture was stirred 10 minutes and solvent removed by evaporation. Residue partitioned between ethyl acetate (3.1 l) and water (3.1 l), extracted further into ethyl acetate (2 × 800 ml). The combined organic extracts were washed with water (3 l), brine (3 l), dried ($MgSO_4$) and evaporated. The residue was purified by flash chromatography on silica eluting with 50% ethyl acetate in isohexane to give the product (210 g). ^{1}H NMR δ (400 MHz, DMSO) 2.27 - 2.34 (m, 2H), 4.11 (t, 2H), 4.54 (t, 2H), 8.83 (d, 1H), 8.92 (d, 1H); m/z 198 $(M+H)^+$.

Preparation of Form B by seeding

To a sample of Form A (3.9 g, 9.3 mmol) was added ispropanol (3 mL). A sample of seed crystals of Form B prepared previously (20 mg) was added, and the resulting slurry was stirred at room temperature for 3 days. The solid was isolated by filtration and dried under vacuum (3.31 g, 85%). The DSC indicated complete conversion to the new form, melting point 136.4 (onset).

^{1} H NMR δ (400 MHz, $CDCl_3$) 1.36 (6H, d), 2.34 - 2.42 (2H, m), 4.25 (2H, t), 4.55 - 4.61 (1H, m), 4.68 (2H, t), 6.83 (1H, d), 7.25 (1H, t), 7.33 - 7.34 (1H, m), 7.39 (1H, d), 8.37 (1H, d), 8.80 (1H, d), 10.42 (1H, s).

X-Ray Powder Diffraction of Form B

Table B

% Relative Intensity*	Definition
25 - 100	vs (very strong)
10 - 25	s (strong)
3 - 10	m (medium)
1 - 3	w (weak)

* The relative intensities are derived from diffractograms measured with fixed slits Analytical Instrument: Siemens D5000.The X-ray powder diffraction spectra were determined by mounting a sample of the crystalline material on a Siemens single silicon crystal (SSC) wafer mount and spreading out the sample into a thin layer with the aid of a

microscope slide. The sample was spun at 30 revolutions per minute (to improve counting statistics) and irradiated with X-rays generated by a copper long-fine focus tube operated at 40kV and 40mA with a wavelength of 1.5406 angstroms. The collimated X-ray source was passed through an automatic variable divergence slit set at V20 and the reflected radiation directed through a 2mm antiscatter slit and a 0.2mm detector slit. The sample was exposed for 1 second per 0.02 degree 2-theta increment (continuous scan mode) over the range 2 degrees to 40 degrees 2-theta in theta-theta mode. The running time was 31 minutes and 41 seconds. The instrument was equipped with a scintillation counter as detector. Control and data capture was by means of a Dell Optiplex 686 NT 4.0 Workstation operating with Diffract+ software. Persons skilled in the art of X-ray powder diffraction will realise that the relative intensity of peaks can be affected by, for example, grains above 30 microns in size and non-unitary aspect ratios that may affect analysis of samples. The skilled person will also realise that the position of reflections can be affected by the precise height at which the sample sits in the diffractometer and the zero calibration of the diffractometer. The surface planarity of the sample may also have a small effect. Hence the diffraction pattern data presented are not to be taken as absolute values.

Differential Scanning Calorimetry

Analytical Instrument: Mettler DSC820e.Typically less than 5mg of material contained in a 40µl aluminium pan fitted with a pierced lid was heated over the temperature range 25°C to 325°C at a constant heating rate of 10°C per minute. A purge gas using nitrogen was used - flow rate 100ml per minute.

Claims

1. A crystalline form of the compound 3-{[5-(azetidin-1-ylcarbonyl)pyrazin-2-yl]oxy}-5-[(1-methylethyl)oxy]-N-1H-pyrazol-3-ylbenzamide having an X-ray powder diffraction pattern with peaks at at least one of the following 2-theta values measured using CuKa radiation: 24.6° and 18.0°.

2. A crystalline form as claimed in claim 1 having an X-ray powder diffraction pattern with peaks at the following 2-theta values measured using CuKa radiation: 24.6° and 18.0°.

3. A crystalline form as claimed in claim 1 having an X-ray powder diffraction pattern with peaks at the following 2-theta values measured using CuKa radiation: 24.6°, 18.0° and 25.6 °.

4. A crystalline form as claimed in claim 1 having an X-ray powder diffraction pattern with peaks at the following 2-theta values measured using CuKa radiation: 24.6°, 18.0°, 25.6 ° and 23.8 °.

5. A crystalline form as claimed in claim 1 having an X-ray powder diffraction pattern with peaks at the following 2-theta values measured using CuKa radiation: 24.6°, 18.0°, 25.6°, 23.8 ° and 11.5 °.

6. A crystalline form as claimed in claim 1 having an X-ray powder diffraction pattern with peaks at the following 2-theta values measured using CuKa radiation: 24.6°, 18.0°, 25.6°, 23.8 °, 11.5° and 9.1 °.

7. A crystalline form as claimed in claim 1 having an X-ray diffraction pattern substantially the same as the X-ray diffraction pattern shown in Figure A.

8. A crystalline form of the compound 3-{[5-(azetidin-1-ylcarbonyl)pyrazin-2-yl]oxy}-5-[(1-methylethyl)oxy]-N-1H-pyrazol-3-ylbenzamide having a melting point of about 136.8°C (onset).

9. A pharmaceutical composition comprising a crystalline form as claimed in any one of claims 1 to 8, together with a pharmaceutically acceptable carrier.

10. A process for formation of a crystalline form as defined in any one of claims 1 to 8 from a solution of form A or A' in isopropanol.

11. A compound according to any one of claims 1 to 8 for use as a medicament.

12. A compound according to Claim 11, wherein the medicament is a medicament for treatment of a disease mediated through GLK, in particular type 2 diabetes.

13. The use of a compound according to any one of claims 1 to 8 in the preparation of a medicament for treatment of a disease mediated through GLK.

14. The use of a compound according to any one of claims 1 to 8 in the preparation of a medicament for treatment of type 2 diabetes.

15. A method of treating GLK mediated diseases by administering an effective amount of a compound of any one of claims 1 to 8 to a mammal in need of such treatment.

16. The method of claim 15 wherein the GLK mediated disease is type 2 diabetes.

Figure A: X-Ray Powder Diffraction Pattern of Form B

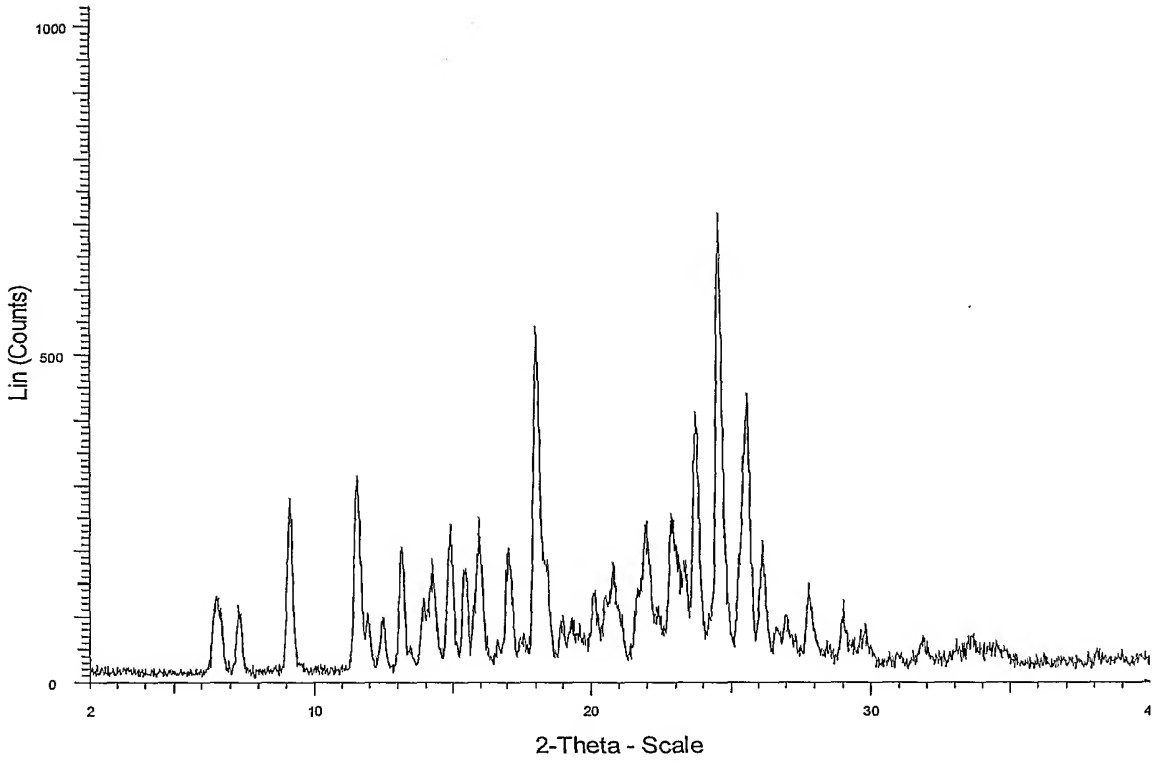
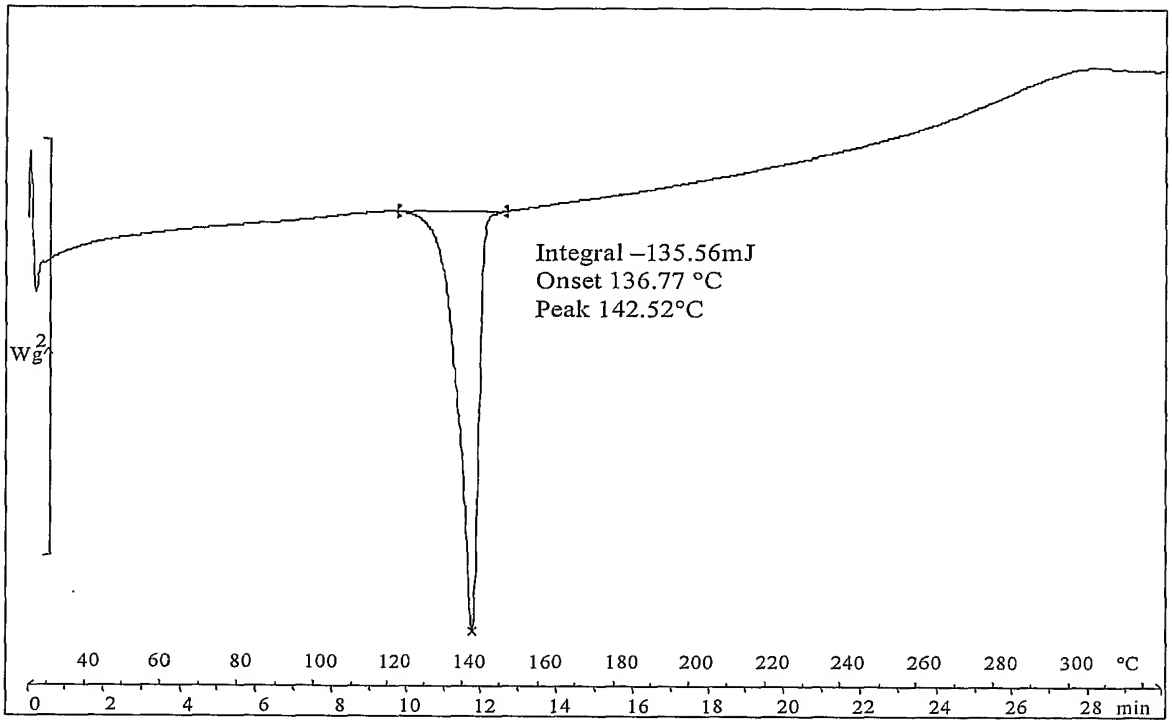


Figure B: DSC Thermogram of Form B



INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2007/004925

A. CLASSIFICATION OF SUBJECT MATTER
INV. C07D403/14 A61K31/496 A61P3/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C07D A61K A61P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, BIOSIS, EMBASE, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	WO 2006/040528 A (ASTRAZENECA AB [SE]; ASTRAZENECA UK LTD [GB]; JOHNSTONE CRAIG [GB]; MC) 20 April 2006 (2006-04-20) abstract; claims 1-18 page 70 - page 72 examples 2,3	1-16

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
13 March 2008	27/03/2008

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2007/004925

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

International application No
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